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VARIATION OF THE DEER-MOUSE (*PEROMYSCUS MANICULATUS*) IN PARTS OF IDAHO, MONTANA, UTAH, AND WYOMING

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INTRODUCTION

The stocks of deer-mice described in this report are the laboratory-bred descendents of animals taken at localities scattered over an area of considerable geographic extent in the northern Rocky Mountains region. The collecting stations lie in Idaho, Montana, Utah, and Wyoming. This area is highly diversified ecologically and includes such vegetational types as grassy plains, sagebrush-covered canyons, lowland conifer forest, and timberline forest. It is not surprising, therefore, that the deer-mice living in the region exhibit considerable geographic variability in their body dimensions and pelage color.

ACKNOWLEDGMENTS

The stock of deer-mice from Arco was collected by Philip M. Blossom. Olaus Murie collected the stocks from Bear Lake and Logan Canyon. The stock from Flat Creek was secured by Adolph Murie. All the other stocks were secured by me in 1933 while on an expedition sponsored jointly by the Carnegie Institution of Washington and the Museum of Zoology of the University of Michigan. The animals were reared and cared for and the study was completed in the Laboratory of Vertebrate Biology.

METHODS

All the mice herein described were born in the laboratory. After being reared under standard conditions to an approximate age of one year they were killed by ether and prepared as specimens (Dice, 1932: 5–7, 19–22). The body measurements were all made by myself. The measurements of the skull and femur and also the color readings have been made by various assistants. Donald M. Clarke carried out the statistical calculations.

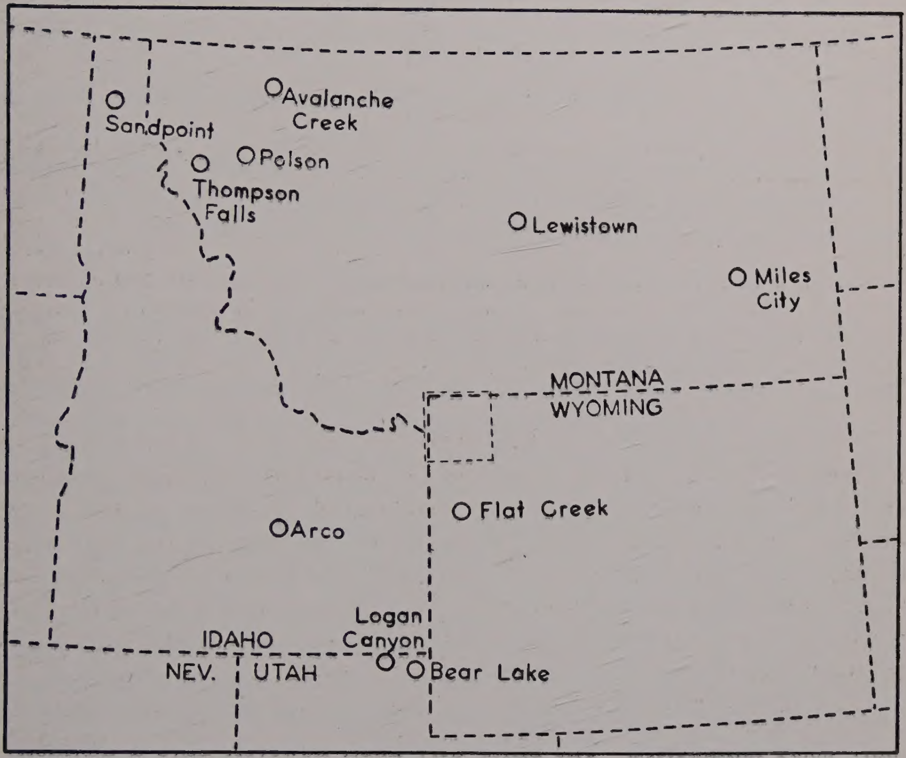
The importance of the difference between any two comparable means is usually evaluated statistically by use of the standard errors. This method, however, suffers from the difficulty that the magnitude of the standard error changes with the size of the sample. If the samples are made very large, practically every animal population can be shown to differ significantly from every other population. The difference between the means of two populations, for any particular measurement, might, therefore, be statistically significant when it is so small as to be of negligible ecological importance.

The standard error is nevertheless a useful statistic for comparing the means of the *Peromyscus* measurements. The animals included in each laboratory stock usually number between twenty-five and one hundred, and the standard errors of the several stocks, therefore, are roughly of about the same order of magnitude. In my studies of variation in *Peromyscus* I have employed a rather high standard of significance when making comparisons between means. No difference between two means that is less than 2.7 times the standard error of their difference is considered to be significant (Dice and Leraas, 1936). This procedure minimizes to some degree minor differences between the means.

Significance, used in a statistical sense, however, is only a measure of the probability that the difference between the means compared is a deviation that is not due to chance, and it is not a measure of the degree of divergence between the populations under consideration. To measure the degree of divergence between populations for any particular measured character, the standard deviation may be employed. This statistic has the advantage that it remains practically constant no matter how many individuals are included in the sample of the population from which it is derived.

In a symmetrical frequency curve 68.3 per cent of the measurements of any population should fall within one standard deviation above or below the mean. Conversely, 31.7 per cent of the measurements will fall farther from the mean than one standard deviation. Half of these measurements may be expected to be above the mean and half below it. Accordingly, slightly less than 16 per cent of the measurements will be greater than the mean plus one standard deviation and slightly less than 16 per cent will be less than the mean minus one standard deviation.

If for any given measurement the mean of one population plus once its standard deviation should be exactly equal to the mean minus once the standard deviation of another population, then only 16 per cent of each population would overlap in the resulting frequency curve. This curve would, of course, be bimodal, and 84 per cent of each of the two populations could be separated from the other on the basis of this measurement (Hubbs and Perlmutter, 1942). Should the means of the two populations compared differ by an amount greater than the sum of their respective standard deviations, the amount of overlap of the two curves will be less than 16 per cent. The standard deviation when used in this way, therefore, gives a valuable measure of the degree of divergence between populations. A precise estimate of the amount of overlap between any two populations may if desired, be calculated from the two standard deviations, but this will seldom be necessary.



MAP 1. Part of the northern Rocky Mountains region, showing collecting localities for the stocks of deer-mice.

COLLECTING STATIONS

Breeding stocks of deer-mice for this study were secured at the following localities (Map 1).

Arco. On the cinder-covered slopes of Grassy Cone, at the northwest boundary of the Craters of the Moon National Monument, twenty-six miles southwest of Arco, in Butte County, Idaho.

Avalanche Creek. In heavy cedar forest at Avalanche Creek Camp Ground, Glacier National Park, fifteen miles northeast of Belton, in Flathead County, Montana.

Bear Lake. In a short, steep canyon four miles east of the southern end of Bear Lake, in Rich County, Utah.

Flat Creek. At an elevation of about 9500 feet, near timberline, on the divide between Flat Creek and Granite Creek, nine miles east of Jackson, in Teton County, Wyoming.

Lewistown. Two and a half miles west of Lewistown, in Fergus County, Montana.

Logan Canyon. In Logan Canyon, twenty miles by road from Logan, in Cache County, Utah.

Miles City. Along Spring Creek, thirteen miles by road east of Miles City, in Custer County, Montana.

Polson. Along the shore of Flathead Lake, just west of Polson, in Lake County, Montana.

Sandpoint. Four miles south of Sandpoint, in Bonner County, Idaho.

Thompson Falls. In the valley of the Clark Fork of the Columbia four miles northwest of Thompson Falls, in Sanders County, Montana.

VARIATION IN SIZE

The greatest difference in dimensions between the ten laboratory-bred stocks of deer-mice here compared is in length of tail (Table I). The Avalanche Creek, Sand Point, and Thompson Falls stocks have relatively long tails, and the Arco, Lewistown, and Miles City stocks have short tails. The mean of this measurement for any one of the three long-tailed stocks exceeds the mean of any one of the short-tailed stocks, with one exception, by an amount greater than the sum of the standard deviations of the two stocks compared. The difference between the Thompson Falls and Arco stocks (9.73 mm.) is slightly less than the sum of their standard deviations (9.86 mm.). The differences in means between the long-tailed and short-tailed groups of deer-mice are very striking. The Avalanche Creek stock, which has the highest mean for this measurement, averages 81.10 millimeters in tail length, and the Miles City stock, which has the shortest tail, averages only 60.94 millimeters. The Miles City mice, however, have a distinctly shorter tail than the other mice of the short-tailed group, both those from Lewistown, which have a mean tail length of 64.63 millimeters, and those from Arco, with a mean of 68.51 millimeters. The remaining four stocks, those from Polson, Flat Creek, Logan Canyon, and Bear Lake, are intermediate in tail length.

The ears of these stocks of deer-mice also exhibit important differences in size. The stocks from Polson, Avalanche Creek, Thompson Falls, and Sand Point average longest in ear length, and those from Miles City and Lewistown average shortest. The differences in this dimension between the members of the large-eared and small-eared groups are greater than the sum of the respective standard deviations of any two means that may be compared. The ear length of the Polson mice, which are largest in this measure-

TABLE I

Measurements of *Peromyscus maniculatus* from the Northern Rocky Mountains Area

Means, standard errors, and standard deviations for 1-year age class, both sexes, in millimeters

Stock	No.	Mean Age in Weeks	No. of Parents	Body Length	Tail Length	Hind-foot Length	Ear Length
artemisiae							
Avalanche Creek	42	54	5	97.83 ± .56 (3.66)	81.10 ± .64 (4.13)	20.800 ± .080 (.518)	18.759 ± .112 (.697)
Flat Creek	80	45	16	95.94 ± .48 (4.32)	71.38 ± .68 (6.09)	20.441 ± .057 (.514)	17.994 ± .080 (.718)
Polson	79	55	5	95.13 ± .47 (4.12)	72.67 ± .54 (4.54)	20.173 ± .075 (.660)	18.812 ± .077 (.673)
Sand Point	32	55	4	96.84 ± .69 (3.87)	80.29 ± .74 (4.12)	20.278 ± .109 (.615)	18.494 ± .094 (.532)
Thompson Falls	97	54	10	97.97 ± .41 (3.99)	78.24 ± .53 (5.06)	20.670 ± .058 (.567)	18.716 ± .024 (.234)
osgoodi							
Lewistown	61	53	5	100.08 ± .53 (4.12)	64.63 ± .67 (5.21)	19.998 ± .086 (.667)	17.063 ± .058 (.447)
Miles City	69	57	6	95.10 ± .46 (3.83)	60.94 ± .41 (3.40)	20.137 ± .063 (.524)	17.326 ± .077 (.637)
sonoriensis							
Arco	115	56	13	96.08 ± .35 (3.76)	68.51 ± .45 (4.80)	20.346 ± .063 (.680)	18.361 ± .068 (.729)
Bear Lake	26	52	5	94.00 ± .79 (4.02)	69.38 ± .84 (4.11)	19.762 ± .131 (.666)	18.138 ± .141 (.717)
Logan Canyon	63	46	8	93.78 ± .47 (3.74)	71.10 ± .60 (4.75)	20.436 ± .075 (.592)	17.769 ± .078 (.616)

	Femur	Mandible	Condyle-premaxilla	Condyle-zygoma	Bullar Width
artemisiae					
Avalanche Creek	15.993 ± .090 (.576)	16.602 ± .055 (.358)	24.939 ± .075 (.482)	17.940 ± .054 (.340)	11.110 ± .031 (.196)
Flat Creek	16.254 ± .070 (.614)	16.207 ± .047 (.410)	24.661 ± .059 (.519)	17.505 ± .048 (.417)	11.012 ± .027 (.241)
Polson	15.769 ± .092 (.716)	16.192 ± .061 (.474)	24.588 ± .088 (.678)	17.519 ± .067 (.513)	11.115 ± .035 (.276)
Sand Point	15.913 ± .092 (.516)	16.069 ± .069 (.390)	24.890 ± .092 (.514)	17.716 ± .059 (.331)	10.819 ± .038 (.217)
Thompson Falls	16.247 ± .071 (.689)	16.549 ± .048 (.467)	24.946 ± .069 (.680)	17.711 ± .047 (.456)	11.028 ± .024 (.233)
osgoodi					
Lewistown	16.503 ± .085 (.653)	16.163 ± .053 (.405)	24.561 ± .094 (.725)	17.703 ± .068 (.520)	10.983 ± .035 (.270)
Miles City	15.978 ± .082 (.681)	16.370 ± .046 (.388)	24.352 ± .064 (.529)	17.726 ± .045 (.368)	11.036 ± .029 (.240)
sonoriensis					
Arco	16.061 ± .060 (.643)	15.938 ± .039 (.420)	24.188 ± .060 (.641)	17.177 ± .042 (.451)	10.859 ± .024 (.254)
Bear Lake	16.196 ± .120 (.598)	16.084 ± .083 (.413)	24.452 ± .107 (.535)	17.472 ± .071 (.353)	10.948 ± .040 (.202)
Logan Canyon	16.152 ± .075 (.589)	15.858 ± .047 (.368)	24.171 ± .068 (.539)	17.059 ± .041 (.329)	10.751 ± .029 (.232)

ment, averages 18.812 millimeters, and that of the Lewistown mice, which are smallest, averages 17.063 millimeters.

None of the other body measurements and none of the measurements of the skull or femur differ between the several stocks in any consistent and important way. Only in length of mandible and in the condylo-zygomatic measurement of the skull are the means of the Avalanche Creek mice greater than those of the Logan Canyon mice by amounts that are greater than the sums of the two respective standard deviations.

TABLE II

PELAGE COLOR OF *Peromyscus maniculatus* FROM THE NORTHERN ROCKY MOUNTAINS AREA

Mean tint-photometer readings, standard errors, and standard deviations for 1-year age class, both sexes, in per cent

Stock	Dorsal Stripe		
	Red	Green	Blue-violet
artemisiae			
Avalanche Creek	8.21 ± .20 (1.26)	6.12 ± .15 (.98)	4.76 ± .13 (.84)
Flat Creek	9.60 ± .23 (2.06)	6.94 ± .18 (1.81)	5.19 ± .14 (1.57)
Polson	9.56 ± .12 (1.08)	7.58 ± .11 (.98)	5.84 ± .10 (.90)
Sand Point	7.64 ± .28 (1.56)	6.00 ± .22 (1.24)	4.68 ± .17 (.96)
Thompson Falls	7.65 ± .12 (1.21)	5.88 ± .10 (1.02)	4.47 ± .09 (.84)
osgoodi			
Lewistown	10.27 ± .17 (1.34)	7.85 ± .16 (1.28)	5.67 ± .13 (1.04)
Miles City	13.54 ± .27 (2.23)	10.37 ± .21 (1.77)	7.89 ± .17 (1.41)
sonoriensis			
Arco	9.51 ± .17 (1.83)	7.34 ± .14 (1.46)	5.51 ± .11 (1.11)
Bear Lake	12.27 ± .27 (1.52)	9.33 ± .16 (.91)	7.09 ± .17 (1.00)
Logan Canyon	11.68 ± .20 (1.54)	8.97 ± .17 (1.30)	7.08 ± .17 (1.28)
	Side Stripe		
artemisiae			
Avalanche Creek	16.07 ± .31 (2.01)	11.93 ± .26 (1.67)	9.14 ± .23 (1.51)
Flat Creek	18.95 ± .21 (1.86)	13.68 ± .17 (1.89)	9.84 ± .15 (1.47)
Polson	17.43 ± .24 (2.26)	13.86 ± .21 (1.93)	11.23 ± .19 (1.75)
Sand Point	15.65 ± .32 (1.79)	11.58 ± .22 (1.24)	9.26 ± .20 (1.11)
Thompson Falls	14.96 ± .19 (1.91)	11.37 ± .15 (1.46)	8.62 ± .12 (1.18)
osgoodi			
Lewistown	19.72 ± .34 (2.66)	14.55 ± .28 (2.20)	11.10 ± .24 (1.85)
Miles City	24.83 ± .39 (3.25)	18.81 ± .27 (2.27)	14.26 ± .22 (1.83)
sonoriensis			
Arco	18.61 ± .24 (2.58)	14.22 ± .19 (1.97)	10.98 ± .15 (1.60)
Bear Lake	22.94 ± .40 (2.32)	18.00 ± .33 (1.92)	13.55 ± .32 (1.83)
Logan Canyon	22.43 ± .24 (1.84)	16.62 ± .22 (1.68)	12.68 ± .19 (1.50)

It will be noted that the Avalanche Creek, Sand Point, and Thompson Falls stocks are notable for both long tails and large ears, when compared to the other stocks here described. Likewise, the Miles City and Lewistown mice have both short tails and small ears. On the other hand, the Arco mice, which have fairly short tails, rank only intermediate among the other stocks in ear size. Furthermore, the Polson mice, which average large in ear size, rank only intermediate among the stocks in length of tail.

VARIATION IN PELAGE COLOR

The pelage of the Miles City, Bear Lake, and Logan Canyon mice is relatively pale compared to that of the other seven stocks. This is shown by their high average tint photometer readings. On the other hand, the Thompson Falls, Sand Point, and Avalanche Creek mice are relatively dark, as shown by low readings. The difference between any given mean color reading for any one of the pale stocks listed and the comparable mean of any one of the dark stocks is greater than the sums of the two respective standard deviations. This is true for each color screen, red, green, and blue-violet, and for both dorsal and side stripes. The other four stocks, those from Lewistown, Flat Creek, Arco, and Polson, are intermediate in shade of pelage (Table II).

TAXONOMIC RELATIONS OF THE STOCKS

The stocks of deer-mice from Sand Point, Thompson Falls, and Avalanche Creek agree in being dark in pelage and in having long tails and large ears, when compared with the other seven stocks here described. The three collecting stations named lie within the geographical range assigned to the subspecies *Peromyscus maniculatus artemisiae* (Osgood, 1909 : 58–60; Davis, 1939, Fig. 23), and their characters agree with the diagnosis of that form. Measurements of another stock of *artemisiae* from St. Mary, Glacier Park, Montana, have previously been given by Murie (1933). Murie's animals, however, were not bred in the laboratory, and his measurements, therefore, are not exactly comparable to those of the stocks here described. The St. Mary mice, nevertheless, agree with the mice here assigned to *artemisiae* in having relatively long tails, large ears, and dark pelage color.

The subspecies *artemisiae* is an inhabitant of the conifer forests of the northern Rocky Mountains in western Montana, northern Idaho, eastern Washington, and the adjacent parts of British Columbia. The type locality is Ashcroft, British Columbia. The subspecies has been identified as far south as the Blue Mountains of southeastern Washington. Measurements have previously been given of laboratory-bred stocks from Pullman, Lyons Ferry (north side of Snake River), Palouse Falls, Dayton, Hompeg Falls, and Godman Springs, in Washington, and from Troy in Idaho (Dice, 1939: 21). There are, however, considerable differences between these several stocks, and not all of them combine the characters of long tail, large ear, and dark pelage color.

The mice from Miles City differ from *artemisiae* by having relatively short tails, small ears, and pale pelage. They may be assumed to represent the subspecies *osgoodi* (Mearns, 1911), whose type locality of Calf Creek, Custer County, Montana, is in the same county as the Miles City collecting station. The subspecies *osgoodi,* which was discussed by Osgood (1909 : 75) under the name *nebrascensis,* occupies a considerable range in eastern Montana and in the neighboring states and provinces. It is in general an inhabitant of semiarid grass or sagebrush-covered plains and foothills.

Laboratory-bred stocks of deer-mice assigned to the subspecies *osgoodi* have previously been described from three localities in northeastern Utah (Leraas, 1938), from several localities in western North Dakota (Dice, 1940), from one locality in eastern Wyoming and one in western Nebraska (Dice, 1941), and from several localities in the Black Hills region of South Dakota and adjacent Wyoming (Dice, 1942). In addition, Murie (1933) has given the measurements of a stock captured alive at St. Mary, on the eastern side of Glacier Park, Montana, and reared to maturity in the laboratory. These several stocks of *osgoodi* differ considerably among themselves in dimensions and in pelage color. They, however, in general agree in having relatively short tails and pale color when compared to *artemisiae.*

The Polson locality lies within the range of *artemisiae,* though it is in a wide valley that is mostly covered by grass rather than by conifer forest. The mice average significantly smaller than the Avalanche Creek, Sand Point, and Thompson Falls stocks in tail length, but exceed those stocks slightly, though not significantly, in ear length. For neither measurement are the differences between the means as great as two standard deviations. The Polson mice on the other hand exceed the Miles City mice significantly in both tail length and in ear length, and the differences are greater than the sums of the respective standard deviations. In tint photometer readings of pelage color the Polson mice average more or less intermediate between *artemisiae* and *osgoodi.* On the basis of their dimensions and geographical origin they may be assigned to *artemisiae.* The paler color of their pelage compared to that of the mice of the other *artemisiae* stocks is perhaps correlated with the scantiness of forests in the vicinity of their collecting station.

The Lewistown locality lies on the eastern margin of the range of *artemisiae.* The situation is partly surrounded by mountains. Conifer forest here alternates extensively with grass-covered hills. The collecting station itself was in open fields. The mice of this stock average small both in tail length and ear length, and their means do not differ significantly from those of the Miles City mice. In pelage color they are somewhat intermediate between *artemisiae* and the Miles City *osgoodi,* but their tint photometer readings are closest to those of the Miles City mice. The Lewistown stock may accordingly be assigned to *osgoodi,* though it is not fully typical in color.

The Flat Creek locality is in northwestern Wyoming, south of Yellowstone Park, and considerably southeast of the main range of *artemisiae.* Osgood (1909: 61), however, assigns specimens from this region to that subspecies. The Flat Creek mice significantly exceed both the Lewistown and Miles City mice in tail length and ear length. The difference in their tail length from that of the Miles City mice exceeds the sum of the two respective standard deviations, but their difference from the Lewistown mice is not so great. The difference in ear length between the Flat Creek and the Miles City and Lewistown mice is less than two standard deviations. The Flat

Creek stock is significantly exceeded in both tail length and ear length by the four stocks of this group already assigned to *artemisiae,* though the differences between the means are not as great as the sums of the respective standard deviations. In tint photometer readings of pelage color the Flat Creek mice are intermediate between the stocks of *artemisiae* and the Miles City *osgoodi.* On the basis of their rather long tails the Flat Creek mice may be assigned to *artemisiae,* but they are not typical of that subspecies either in measurements or pelage color.

The Arco locality falls within the range of the subspecies *sonoriensis* (Davis, 1939, Fig. 23). This subspecies is said by Osgood (1909 : 75, 89–94) not to differ greatly in color from *osgoodi* (there called *nebrascensis*), but to be somewhat larger in size and to have a longer tail.

The differences in dimensions between the mice of the subspecies *osgoodi* and *sonoriensis,* however, are not very conspicuous nor always consistent. Compared to a stock of undoubted *sonoriensis* from Miller Canyon, Arizona (Dice, 1938*a*), from only a short distance northeast of the type locality of that subspecies, the Miles City *osgoodi* do not differ significantly in the means of either body length or of tail length. The Miles City mice have the larger ears, the difference in means being 0.390 ± .110 millimeters, which is statistically significant. The differences between the two stocks in pelage color readings are not consistent, the Miles City mice averaging darker than the Miller Canyon mice on the dorsal stripe but paler on the side of the body. There is, therefore, no important difference either in body dimensions or in pelage color between these two laboratory-bred stocks representing, respectively, *osgoodi* and *sonoriensis.*

The Arco mice are appreciably darker than *osgoodi* from Miles City, as shown by their significantly lower tint photometer readings (Table II). The Arco locality, however, is in an area where there is a considerable amount of dark lava, and it is likely, therefore, that a dark local race of these mice has developed in that vicinity. There is no significant difference in body length between the Miles City and Arco stocks. The Arco stock significantly exceeds the Miles City stock in both tail length and ear length, though for neither measurement is the difference between the two respective means as great as the sum of their standard deviations.

Compard to *sonoriensis* from Miller Canyon, the Arco mice do not differ significantly in body length, but are significantly the larger in tail length and are considerably the darker in pelage, both on the dorsal stripe and on the side of the body. A stock of *sonoriensis* from Victorville, California (Dice, 1938*b,* Tables III and IV), significantly exceeds the Arco stock in tail length, ear length, and in readings of pelage color. This Victorville stock, however, was considerably inbred in the laboratory, and it may not well represent the wild population in that part of the Mohave Desert.

The Arco stock is therefore assigned to the subspecies *sonoriensis* because of the geographical position of the locality, rather than because of any important demonstrated difference in characters from the mice of the subspecies *osgoodi.* The Arco stock, furthermore, may be assumed to represent a dark but probably weakly differentiated local race.

The Bear Lake and Logan Canyon localities are both in the canyons of northeastern Utah, where grass and sagebrush alternate with shrubby thickets and with stands of juniper and other trees. The mice of both these stocks average more or less intermediate in tail length and ear length between *artemisiae* and the Miles City *osgoodi.* In pelage color they also are intermediate, but closest to the Miles City stock. The differences in tint photometer readings between them and the Miles City mice are statistically significant for most color comparisons when measured by the standard errors, but are always less than the sum of the two respective standard deviations. On the contrary, the differences in mean tint photometer readings between the two Utah stocks and those of the subspecies *artemisiae* from Sand Point, Avalanche Creek, and Thompson Falls are always greater than the sum of the two respective standard deviations.

Compared to a stock of laboratory-bred mice from Little Spring, Arizona (Dice, 1938*a,* Tables III and IV), which may be assumed to be the type locality of *rufinus,* the two Utah stocks average considerably longer in tail length. In ear length the Little Springs stock averages the longer, but the differences from the Utah stocks are not very great. In pelage color the Utah stocks are considerably paler than the Little Springs stock, and the differences in tint photometer readings are of high statistical significance. On the basis of pelage color, therefore, these two Utah stocks cannot be referred either to *artemisiae* or *rufinus.*

Compared to *sonoriensis* from Miller Canyon, Arizona (Dice, 1938*a,* Tables III and IV), the two Utah stocks average significantly longer in tail length and ear length. In tint photometer readings for dorsal stripe red the Utah stocks average significantly lower than the Miller Canyon stock, but there is very little difference between them in the color of the side of the body.

The Logan Canyon and Bear Lake mice are rather close to the Arco mice in their characters. They do not differ in any important way in ear length nor tail length. The Utah stocks are slightly paler than the Arco stock in pelage. The differences in tint photometer readings are statistically significant when measured by the standard errors, but are not so great as the sums of the respective standard deviations.

The Bear Lake and Logan Canyon stocks also closely resemble some of the stocks from the Uinta Mountains region, northeastern Utah, assigned by Leraas (1938) to *osgoodi.* There is, however, so much variability among the deer-mice living in this ecologically diversified region, that any precise delimitation here between the ranges of *sonoriensis* and *osgoodi* is impossible with the information at hand. Because of their relatively long tails as compared to the Miles City mice and their similarity to the Arco mice, the Logan Canyon and Bear Lake stocks are here tentatively assigned to *sonoriensis.*

DISCUSSION

In the geographical area covered by the collecting stations whence the breeding stocks for this study were secured the deer-mice are of two strikingly different types. The geographic race or subspecies called *artemisiae* is a dark, long-tailed, and large-eared form, which is mostly restricted to the conifer forests of the mountains. On the grass-covered or sage-brush-covered plains and hills most of the deer-mice are pale in pelage color and have relatively short tails and small ears. They are assigned to the two subspecies *osgoodi* and *sonoriensis*. The tail of *sonoriensis* is said to average slightly longer in length than the tail of *osgoodi,* but the differences in the characters of these two forms are not well marked.

The several laboratory-bred stocks assigned to the same subspecies often differ considerably from one another in their average dimensions and pelage color. Considerable variations from place to place in the characters of the field populations of these deer-mice are thereby indicated, even within the range of a single subspecies. A few stocks are more or less intermediate between two adjacent subspecies, and their exact subspecific assignment has had to be made more or less arbitrarily.

Where the ranges of *artemisiae* and *osgoodi* meet at the western border of the mountains at Glacier Park, Montana, these two forms do not interbreed, and they occupy different types of habitats (Murie, 1933). It is, however, not certain that the two forms are everywhere so sharply separated. It is possible that there is interbreeding between them at some places where the two forms meet north or south of Glacier Park.

The long tail of the subspecies *artemisiae* is probably an adaptation for semiarboreal life in a forest habitat. The shorter tails of the subspecies *osgoodi* and *sonoriensis* may likewise be an adaptation for cursorial life in open fields. There is no evidence at hand, however, to prove that length of tail actually is an important factor in the survival of either of these forms. Neither is there any evidence that the differences in the size of the ear that distinguish these forms are of adaptive significance.

The prevailing dark pelage of the subspecies *artemisiae* is undoubtedly correlated in general with life in heavy conifer forest. Likewise, the paler pelages of *osgoodi* and *sonoriensis* are probably correlated with life in more sparsely vegetated habitats.

The climate of the montane-forest belt that is the home of *artemisiae* undoubtedly differs in important respects from the climate of the lower belt that is the habitat of *osgoodi* and *sonoriensis.* The climate of each belt undoubtedly determines the type of vegetation that grows there. On the contrary, there is no evidence that the climate in any way directly affects the characters of the deer-mice.

The amount of humus in the soil at any given locality depends to a considerable degree upon the heaviness of the vegetative cover. It would be expected, therefore, that the surface soil would be darker in the habitat of *artemisiae* than in that of *osgoodi* and *sonoriensis*. Soil samples, unfortunately, are available from only a few of the collecting stations where the stocks of mice here described were secured. The readings of the Miles City soil sample average 21.5 per cent for reflected red, and the Thompson Falls soil averages only 10.8 per cent. The Lewistown soil, however, also reads 10.8 per cent for red, in spite of the fact that the mice from this station, though somewhat intermediate in pelage color, are assigned to *osgoodi*. The soil at the Polson station is still paler, with readings for red of 16.6 per cent, though the mice here are assigned to *artemisiae*. The soil at the Arco station averages 7.8 per cent of reflected red, this low reading being undoubtedly due to the presence of volcanic cinders. The mice of the Arco stock are somewhat darker than would be expected of *sonoriensis*. A dark-colored local race has presumably been evolved in that area, in correlation with the dark color there of the surface soil. This evidence, while not fully consistent, agrees in general with the thesis that the pelage color of the upper parts of the mice tends to vary in accordance with the color of the surface soil of their habitat (Dice and Blossom, 1937: 108).

It may be concluded that the differences in characters between the deer-mice of the subspecies *artemisiae* and those of the *osgoodi-sonoriensis* complex are correlated with differences in the climate, vegetation, and soil color of their respective habitats. We have very little precise information, however, about the manner in which any particular character of the animals is influenced by the environment, nor do we know much about how these correlations are brought about or maintained.

SUMMARY

Measurements are given of body dimensions and pelage color for laboratory-bred stocks of deer-mice from ten localities in the northern Rocky Mountains region.

The long-tailed, large-eared, and dark deer-mice of the geographic race *Peromyscus maniculatus artemisiae* are, in general, inhabitants of the montane conifer forests. The shorter-tailed, smaller-eared, and paler mice of the races *osgoodi* and *sonoriensis* live mostly on the grass-covered and sagebrush-covered plains and lower hills. The differences in the characters of these two types of deer-mice are correlated with differences in the climate, vegetation, and soil color of their respective habitats. The precise factors of environment and of organic response involved in producing these correlations are, however, largely unknown.

LITERATURE CITED

DAVIS, WILLIAM B.

1939 The recent mammals of Idaho. Caldwell, Idaho: The Caxton Printers. 400 pp., frontis., 1 map, 33 figs.

DICE, LEE R.

1932 Variation in a geographic race of the deer-mouse *Peromyscus maniculatus*. Occ. Papers Mus. Zool. Univ. Mich., 239: 1–26, 1 fig.

1938*a* Variation in nine stocks of the deer-mouse, *Peromyscus maniculatus,* from Arizona. *Ibid.,* 375: 1–19, 1 map.

1938*b* A study of racial hybrids in the deer-mouse, *Peromyscus maniculatus. Ibid.,* 312: 1–22.

1939 Variation in the deer-mouse (*Peromyscus maniculatus*) in the Columbia Basin of southeastern Washington and adjacent Idaho and Oregon. Contrib. Lab. Vert. Gen. Univ. Mich., 12: 1–22, 1 map.

1940 Intergradation between two subspecies of deer-mouse (*Peromyscus maniculatus*) across North Dakota. *Ibid.,* 13: 1–14, 1 map.

1941 Variation of the deer-mouse (*Peromyscus maniculatus*) on the sand hills of Nebraska and adjacent areas. *Ibid.,* 15: 1–19, 1 map.

1942 Variation of the deer-mouse (*Peromyscus maniculatus*) of the Bad Lands and Black Hills of South Dakota and Wyoming. *Ibid.,* 19: 1–10, 1 map.

DICE, LEE R., AND PHILIP M. BLOSSOM

1937 Studies of mammalian ecology in southwestern North America with special attention to the colors of desert mammals. Publ. Carnegie Inst. Wash., 485: i–iv, 1–129, 8 pls., 8 figs.

DICE, LEE R., AND HAROLD J. LERAAS

1936 A graphic method for comparing several sets of measurements. Contrib. Lab. Vert. Gen. Univ. Mich., 3: 1–3, 1 fig.

HUBBS, CARL L., AND ALFRED PERLMUTTER

1942 Biometric comparison of several samples, with particular reference to racial investigations. Amer. Nat., 76: 582–92.

LERAAS, HAROLD J.

1938 Variation in *Peromyscus maniculatus osgoodi* from the Uinta Mountains, Utah. Contrib. Lab. Vert. Gen. Univ. Mich., 6: 1–13, 2 figs.

MEARNS, EDGAR A.

1911 New names for two subspecies of *Peromyscus maniculatus* (Wagner). Proc. Biol. Soc. Wash., 24: 101–2.

MURIE, ADOLPH

1933 The ecological relationship of two subspecies of *Peromyscus* in the Glacier Park region, Montana. Occ. Papers Mus. Zool. Univ. Mich., 270: 1–17, 2 figs.

OSGOOD, WILFRED H.

1909 Revision of the mice of the American genus Peromyscus. N. Amer. Fauna, 28: 1–285, 8 pls., 12 figs.